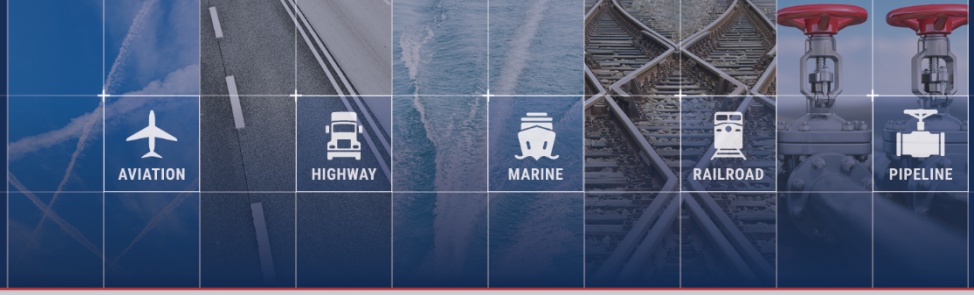

Aviation Investigation Final Report

Location:	Belmont, West Virginia	**Accident Number:**	NYC08LA129
Date & Time:	March 9, 2008, 14:40 Local	**Registration:**	N1078T
Aircraft:	Sikorsky S-58HT	**Aircraft Damage:**	Substantial
Defining Event:	Flight control sys malf/fail	**Injuries:**	1 Serious
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The helicopter was performing external load operations, and was removing a tower from the top of a 620-foot tall smoke stack. After lifting the load clear of the smoke stack, the pilot observed an "over torque" condition on the torque indicator. Several seconds later, the pilot felt a high frequency vibration through the helicopter, and shortly thereafter the tail rotor assembly separated from the helicopter. While the helicopter yawed through two 360-degree rotations, the pilot released the external load, reduced the collective pitch, and performed an autorotation. Postaccident examination of the separated tail rotor assembly revealed that one of the four blades had separated in-flight. Detailed examination of the separated blade revealed that its skins had cracked due to fatigue, and that the blade then separated due to overstress. The adjacent and overlaying doublers also cracked, likely due to fatigue, but no fatigue striations were found on those members. Some ductile dimples were also found in the damaged regions, indicating that at least part of the propagation was by unstable crack growth. The skin fatigue cracks were completely hidden by the overlying doublers, making detection impossible unless the doublers either cracked or were removed. Cracks in the doublers would have been visible on the inboard side of the blade, but not on the outboard side, where the inspection/repair tag covered most of the doubler. The bonds within the blade appeared to be in good condition, and no corrosion was found, suggesting that the blade failure was the result of a fatigue life issue. The helicopter's maintenance manual specified that the tail rotor blades had no life limit, provided that certain flight restrictions were observed, but the investigation was unable to determine whether the helicopter ever exceeded any of the specified flight restrictions. None of the tail rotor blades were in compliance with an existing airworthiness directive, which required the installation of an abrasion strip along the entire length of the blade leading edge; however, it was not clear if this non-compliance affected the failure.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The fatigue failure of a tail rotor blade during an external load lift.

Findings

Aircraft	Tail rotor blade - Fatigue/wear/corrosion

Factual Information

History of Flight

Maneuvering	Flight control sys malf/fail (Defining event)
Maneuvering	Loss of control in flight
Emergency descent	Collision with terr/obj (non-CFIT)

HISTORY OF FLIGHT

On March 9, 2008, about 1440 eastern daylight time, a Sikorsky S-58HT, N1078T, was substantially damaged when it impacted a coal mound during a forced landing near Belmont, West Virginia. The certificated commercial pilot was seriously injured. Visual meteorological conditions prevailed, and no flight plan was filed for the local rotorcraft external load flight, which originated at Mid-Ohio Valley Regional Airport (PKB), Parkersburg, West Virginia. The flight was conducted under 14 Code of Federal Regulations (CFR) Part 133.

During a telephone interview, the pilot stated that the purpose of the flight was to remove construction equipment from a 620-foot tall, operating power plant smoke stack. After successfully picking up five loads of equipment, the pilot refueled the helicopter, and then returned to pick up the sixth and final load.

After lifting the load clear of the smoke stack, the pilot observed an "over torque" condition on the torque indicator, and noted that the external load meter read 5,200 pounds. The pilot elaborated that the helicopter had single- and dual-engine torque limits, and that at the time he observed the over torque condition, the torque indication was above the dual engine limit (110 percent) and below the single engine limit (120 percent). Several seconds later, the pilot felt a high frequency vibration through the helicopter, and shortly thereafter the helicopter began to yaw right. During the yaw, the pilot saw the tail rotor assembly flying free of the helicopter. After the helicopter completed two 360-degree rotations, the pilot released the external load, reduced the collective pitch, and performed an autorotation. The helicopter landed hard on a mound of coal, resulting in substantial damage.

Workers, located on the power plant smoke stack, captured a portion of the accident flight on video. Review of the video revealed that while the helicopter was hovering directly above them, and the load was being attached, the smoke from the stack was blowing in a direction roughly consistent with a right quartering headwind. The helicopter then picked up the load, and turned about 90 degrees right as it flew away from the smoke stack. The video recording stopped shortly thereafter, and resumed as the helicopter descended, just before it impacted the ground.

PERSONNEL INFORMATION

The pilot held a commercial pilot certificate with multiple ratings, including rotorcraft-helicopter. On his most recent application for a Federal Aviation Administration (FAA) second-class medical certificated, dated December 2007, the pilot reported 11,500 total hours of flight experience.

AIRCRAFT INFORMATION

Review of the S-58HT flight manual revealed that the maximum gross weight of the helicopter during external load operations was 13,000 pounds. According to weight and balance data, the basic empty weight of the helicopter was 8,064 pounds. Operator-provided information indicated that the accident flight fuel load was about 850 pounds, the pilot weight was about 200 pounds, and the rigging weight was about 100 pounds.

Review of the lift plan provided by the operator revealed that the stated weight of the equipment being lifted during the accident flight was 3,600 pounds. Following the accident, the equipment was weighed. The actual weight of the equipment was 5,100 pounds.

METEOROLOGICAL INFORMATION

The 1453 weather conditions reported at PKB, located about 7 nautical miles west of the accident site, included winds from 200 degrees at 5 knots, few clouds at 3,600 feet, temperature -1 degrees Celsius (C), dewpoint -7 degrees C, and an altimeter setting of 30.38 inches of mercury.

WRECKAGE AND IMPACT INFORMATION

According to an FAA inspector, the tail rotor assembly, including the 90-degree gearbox, separated from the helicopter, and was found about 600 feet southeast of where the helicopter came to rest. Three of the four tail rotor blades remained attached to the tail rotor assembly, and displayed varying degrees of damage. The grip (attaching) end of the fourth blade forward of the blade spar also remained attached to the tail rotor assembly. The remaining "airfoil" portion of the fourth blade was located about 2 weeks after the accident, on an elevated catwalk about 600 feet east of where the helicopter came to rest.

TESTS AND RESEARCH

The tail rotor assembly and all four blades were forwarded to the National Transportation Safety Board Materials Laboratory for further examination. According to the Materials Laboratory Factual Report, the rotor head was generally intact, and showed rotation of the mast when the input shaft was turned. Damage to the rotor head consisted of a bent pitch change arm, and a detached pitch change assembly at the fourth blade’s grip.

Each tail rotor blade consisted of a forged aluminum root fitting that attached to the grip, and

also formed the blade's leading edge. An airfoil section was bonded to the forging. Each airfoil section had two aluminum sheet skins separated by aluminum honeycomb, and was further reinforced by doubler strips at the inboard attachment area to the root fitting. Each blade had a leading edge abrasion strip that extended from the mid-span point to the blade tip.

The No. 2, 3, and 4 blades were identified by bonded repair/inspection tags on their outboard skins. The No. 1 blade did not have an identification tag. The No. 4 blade, which was last repaired in October 1974, had accumulated 3,492 total hours of operation, and 114 hours since the most recent inspection.

Examination of Tail Rotor Blade No. 4

The No. 4 blade was fractured through the aluminum root fitting near the grip attachment area, and was bent and twisted along the leading edge. The fitting fracture displayed features typical of a bending (out of the plane of rotation) overstress, with no indications of preexisting cracking. Almost the entire portion of the airfoil was separated from the root fitting and leading edge. The separated airfoil portion was relatively straight and undeformed, indicative of separation prior to the deformation of the root fitting. Closer examinations found the separation of the airfoil from the fitting was by fracturing of the skins and doublers, generally along the edges of the root fitting.

Macroscopic examinations of the airfoil skin fractures revealed dull matte gray features, typical of tear overstress fractures in thin sheet aluminum, over the majority of the blade; however, at the inboard end of the airfoil, regions of the fractures showed shiny silvery areas in the skins and doublers. Macroscopically, the shiny regions did not exhibit any significant through-the-thickness yielding deformation that was visible in the overstress fracture regions.

High magnification optical viewing showed relatively flat fracture surfaces in the shiny regions of the skin, and doublers on both sides of the blade; however, fracture features were not optically resolved. Scanning electron microscope (SEM) imaging of the shiny regions revealed heavily damaged surfaces, with isolated areas of undamaged fracture surfaces. The damage was consistent with fracture face re-contact damage, which was indicative of preexisting cracking. While the vast majority of the surfaces were damaged, several small areas of fatigue striations were detected in the undamaged fracture surfaces of the skin separations. All striations emanated from the interior surfaces of the skins. No specific areas of striations were uncovered in the flat shiny portions of the doubler fractures; however, some areas containing ductile dimples were found.

The damaged shiny regions measured about 1.3 inches long in both the skin and doubler on the outboard (top) side of the blade, and about 0.9 inches long on the inboard (bottom) side of the blade. On the outboard side of the blade, the majority of the flat shiny fracture region in the normally visible doubler was hidden underneath the inspection repair tag.

Examination of Tail Rotor Blade No. 3

The No. 3 tail rotor blade was partially fractured through the outboard skin in the same approximate location as the No. 4 blade; however, high magnification inspections of the fracture surface revealed a rough matte gray surface, indicative of overstress on the entire fracture surface, with no indications of preexisting cracking.

ADDITIONAL INFORMATION

Airworthiness Directive (AD) 78-21-05, effective November 30, 1978, and applicable to the part numbers of all four tail rotor blades, required the installation of "improved abrasion strips" per Sikorsky Service Bulletin (SB) number 58B15-18. The stated reason for the AD was, "To prevent possible tail rotor instability." The Sikorsky SB described the installation requirements for "a new stainless steel abrasion strip which covered the entire length of the blade leading edge and had greater chordwise coverage." The SB further stated that the modified blades were to be re-identified as -045 part number blades. The three accident blades that retained their part numbers were identified as either -15 or -16 blades. All four blades from the accident helicopter had leading edge abrasion strips that extended from the mid-span point to the blade tip, instead of the full-span strips required by the AD.

Review of the helicopter's maintenance manual revealed that the tail rotor blades had an unlimited life, provided that the following flight restrictions were complied with: 25 knots maximum sideward flight, minimum 10 seconds hovering turns (360 degrees), and minimum 88 percent Nr (main rotor rpm) on all taxi turns. The investigation was unable to determine whether the helicopter ever exceeded any of the specified flight restrictions.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	48,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane single-engine; Helicopter; Instrument helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	December 12, 2007
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 15, 2007
Flight Time:	12000 hours (Total, all aircraft), 18000 hours (Total, this make and model), 11700 hours (Pilot In Command, all aircraft), 120 hours (Last 90 days, all aircraft), 46 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Sikorsky	**Registration:**	N1078T
Model/Series:	S-58HT	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	58-1016
Landing Gear Type:	Tailwheel	**Seats:**	4
Date/Type of Last Inspection:	December 20, 2007 Continuous airworthiness	**Certified Max Gross Wt.:**	13000 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo shaft
Airframe Total Time:	18397 Hrs at time of accident	**Engine Manufacturer:**	Pratt and Whitney Canada
ELT:	Installed, not activated	**Engine Model/Series:**	PT-6T3
Registered Owner:	St. Louis Helicopters LLC	**Rated Power:**	900 Horsepower
Operator:	St. Louis Helicopters LLC	**Operating Certificate(s) Held:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	PKB,858 ft msl	**Distance from Accident Site:**	7 Nautical Miles
Observation Time:	14:53 Local	**Direction from Accident Site:**	270°
Lowest Cloud Condition:	Few / 3600 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	200°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.37 inches Hg	**Temperature/Dew Point:**	-1°C / -7°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Parkersburg, WV (PKB)	**Type of Flight Plan Filed:**	None
Destination:	(PKB)	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Serious	**Latitude, Longitude:**	39.368057,-81.293891

Administrative Information

Investigator In Charge (IIC):	Diaz, Dennis
Additional Participating Persons:	John Riggs; FAA/FSDO; Charleston, WV
Original Publish Date:	December 24, 2008
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=67636